Reinforced Concrete Bridge (Melan Bridge)
Spanning Dry Creek
Rock Rapids vicinity
Lyon County
Iowa

HAER No. IA-15

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WRITTEN HISTORICAL AND DESCRIPTIVE DATA

Historic American Engineering Record
National Park Service
Department of the Interior
Washington, D. C. 20240

HISTORIC AMERICAN ENGINEERING RECORD

REINFORCED CONCRETE BRIDGE (Melan Bridge)

HAER No. IA-15

Location: Spanning Dry Creek
Rock Rapids Vicinity, Lyon County, Iowa

Date of Construction: 1893

Builder/Designer: Frederick Von Emberger of Vienna, Austria

Present Use: Scheduled for demolition

Significance: One of the first reinforced concrete bridges built in the United States, it is located in Lyon County, 4-1/2 miles southeast of Rock Rapids, Iowa. It was built in 1893 by Frederick Von Emberger, famous Austrian designer, who was at that time the official representative of Joseph Melan, Vienese engineer. Melan was granted an American patent for his method of bridge reinforcement using concrete. The span is thirty feet. The rise of the arch is three feet and the roadway sixteen feet. The thickness of the arch at the crown is six inches. The reinforcing is of the style known as the Melan System and, in this case, consists of five 4" I-beams. The side walls are faced with Sioux Falls jasper. The hand rail is of gas pipe. The cement used was imported from Germany and cost $3.25 per barrel. The mixture of one part cement to two parts sand to four parts broken jasper. The bridge cost $830.00.

Transmitted by: Jean P. Yearby, HAER, 1984

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MELAN ARCH BRIDGE
(Reinforced Concrete Arch Bridge)
Iowa Bridges Recording Project
Emma Slater Park
Rock Rapids
Lyon County
Iowa

HAER No. IA-15

ADDENDUM TO
REINFORCED CONCRETE ARCH BRIDGE
Rock Rapids VIC.
Lyon County
Iowa

BLACK & WHITE PHOTOGRAPHS

REDUCED COPIES OF MEASURED DRAWINGS

WRITTEN HISTORICAL & DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
National Park Service
Department of the Interior
P.O. Box 37127
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HISTORIC AMERICAN ENGINEERING RECORD

MELAN ARCH BRIDGE
(Reinforced Concrete Arch Bridge)

HAER No. IA-15

Location:	Emma Sater park bordering Route 9 on the eastern limit of Rock Rapids, Lyon County, Iowa. Moved from county road 2.3 miles southeast of Rock Rapids. UTM: 14.730310.4812580 USGS: Rock Rapids, Iowa quadrangle (7.5 minute series, 1971)
Date of Construction:	1894
Designer:	Frederick von Emperger, Vienna, Austria; Josef Melan (inventor), Austria
Contractor:	W.S. Hewett, Minneapolis, MN. John Olsen (builder), Rock Rapids, IA.
Present Use:	Pedestrian Bridge
Significance:	Constructed in 1894, the Melan Arch Bridge marks the first experiment in using the innovative concrete-steel system developed by Austrian Josef Melan. At the urging of a Midwestern contractor, Frederick von Emperger, Melan's representative in America, designed a 30 foot concrete arch reinforced with structural steel to span a seasonal stream outside of the small town of Rock Rapids in Northwest Iowa. Although von Emperger's specifications called for 4" I-beams, bent to the elliptical shape of the arch and spaced at 3' intervals, local legend holds that the contractor reinforced the structure with railroad rails to spare expense. Von Emperger went on to design several more arches in the United States, all with dimensions more impressive than this first modest venture. However, the Rock Rapids bridge remains his most significant work, and the Melan system

he introduced there, was adopted widely during the first part of the twentieth century for highway bridges and pedestrian spans.

Historian: Juliet Landler, engineer, August, 1995

Project Information: This document was prepared as part of the Iowa Historic Bridges Recording Project during the summer of 1995 by the Historic American Engineering Record (HAER). The project was sponsored by the Iowa Department of Transportation (IDOT). Preliminary research on this bridge was performed by Clayton B. Fraser of Fraserdesign, Loveland, CO.

In April 1894, a young Austrian named Frederick von Emperger presented a paper at the annual meeting of the American Society of Civil Engineers extolling the wonders of a new modern building material which he called concrete-iron, and which is known today as reinforced concrete.[1] Examples of concrete-iron construction in the United States were rare, he explained, but in Europe this new technology had been in use for at least 16 years, having applications in floor, ceiling, and bridge construction. After giving a detailed history of the development of reinforced concrete, von Emperger offered a list of reasons why the combination of concrete and iron was superior to other building materials, and why this composite material was ideally suited to bridge construction. He described three innovative systems for reinforcing concrete arches: the Monier, the Wünsch, and the Melan. The young Austrian was particularly partial to the latter system which was distinguished by its use of steel I-beams as reinforcement, and which had proven to be strongest when subjected to load testing experiments in Austria.[2] This system,

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[1]Emperger's paper, "The Development and Recent Improvement of Concrete-Iron Bridges," was read April 4, 1894 and published in Transactions-American Society of Civil Engineers, Volume 31, 437-457. An interesting discussion followed, 458-488.

[2]The Austrian Society of Engineers and Architects sponsored a series of experiments to determine the merits of different systems of reinforcement in the late 1890s. Under supervision, the inventor Josef Melan conducted many of these tests from 1886-

he was convinced, could be used to span distances greater than any existing concrete bridge. In fact, for von Emperger, there was "no reason why a system, which has proven better than stone, should not be extended and reach the highest span in use with iron arches."[3] There was one problem: no bridge using this innovative system had been built yet for public use. "To accomplish this in Europe, there is needed, not only the right man and the right place, but also a third one, the right official, who will give his permit. Those three have not yet met," he lamented and cited the government as "an obstacle to progress." Von Emperger concluded his long speech by challenging his audience, "on this account the engineers of this country have a good opportunity to surpass European structures."[4]

It is likely that a man from Minnesota was in attendance that evening. For soon after the lecture, W.S. Hewitt, a contractor, contacted von Emperger and asked him to draw up plans for a small bridge to be constructed in the northwest corner of Iowa. Hewitt's company was based in Minneapolis, but much of his work was conducted in parts of rural Minnesota, Iowa, and South Dakota where the land had been settled only recently, and the demand for bridges was high. In 1894, the year von Emperger presented his paper, Hewitt held multiple-bridge contracts with several counties in Northern Iowa.[5] In Lyon County he had an agreement to build all their new bridges.[6]

Lyon County had been settled during the last few decades of the nineteenth century, making it one of Iowa's youngest counties. Although the United States Government had obtained the land in a 1851 agreement with the Sioux Indians, it was not until 1869 that the last tribes left reluctantly. For the previous few centuries, with its lush prairies and flowing streams, Lyon County had been popular hunting territory for numerous tribes.

1890, and from these experiments, Emperger supplies results.

[3]von Emperger, 57.

[4]Ibid.

[5]Meuser, a former employee of Emperger, in his article in The Cornell Engineer, writes that Hewitt held a blanket contract with two or three counties in Iowa for 1894.

[6]In Book 3 of Proceedings of the Lyon County Board of Supervisors, it was recorded on Nov. 12, 1894 that Hewitt was owed $3,007 for bridges built thus far that year. No other bridge contracts are mentioned in the records for 1894.

Not only had the area provided them with much game, but these were the sacred grounds where they had buried their dead.[7] The pioneers continued their migration west after the Civil War ended. Rock Rapids, the county seat, was founded in 1885. Despite the untamed wilderness, the first settlers of Lyon County made profitable farms out of their sizeable plots, and their prosperity attracted small industries to the area. Several banks set up branches in the county's larger towns. In early 1893, a manufacturing company specializing in world-class banjos moved its headquarters from Chicago to Rock Rapids. That same year, traveling shows began passing through the town almost once a month, and the first county fair was organized. The community's success seemed almost short-lived when months later, a localized depression hit the area. Several of the banks and the banjo factory were forced to close. A drought in 1894 only worsened conditions, and local rail service became irregular.[8]

Seemingly unfettered by the economic situation, local leaders pressed ahead with their efforts to improve the county's infrastructure. On April 5, 1894 the county board of supervisors approved petitions for the building of eighteen bridges. The board was hardly extravagant in granting these requests. In sixteen of the eighteen cases they decided that the bridges, having spans from 40 to 60 feet, should be constructed out of wood, the most inexpensive option available. Of the remaining two bridges, an iron truss was specified for an 80-foot span, and a combination bridge for a 60-foot span. Not surprisingly, reinforced concrete, or concrete-iron construction is not mentioned anywhere in the minutes of the Lyon County Board of Supervisors for the year 1894.

Why Hewitt thought Rock Rapids was an ideal site to try out a new form of bridge construction is somewhat of a mystery. At the time the city was not even a decade old. It was a growing community, but still small. No large cities or major waterways were located nearby. Steel I-beams and a fine quality cement were not available locally. The area, however, afforded one railroad line. Yet what Lyon County lacked in material goods, it made up for in pioneer spirit, and perhaps, this is what first attracted Hewitt. The early settlers shared a love for the new and the unexplored and many were looking to make their mark on the world. Hewitt already knew of one man in Rock Rapids who would wholeheartedly support the idea of reinforced concrete bridge. His name was John Olsen. In 1894 Olsen was still very young, but

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[7]Some of these sacred burial mounds can be seen today.

[8]Smith, Paul and Lucy Jo Colby, Buncombe to 'Twenty Two, 78.

he had already won a $4,000 commission to construct one of Rock Rapids' new churches.[9] In addition to being a respected builder, Olsen was a keen businessman and had established a small factory making concrete blocks. Years later the focus of his business changed from manufacturing concrete block to manufacturing a machine which formed concrete block, an invention Olsen had patented. Throughout the early history of Rock Rapids, he was an active promoter of concrete technology, so it is not surprising that Hewitt contacted him for help in construction the first Melan Arch bridge. Records list Hewitt as the contractor of the bridge, and credit Olsen as the builder.

According to local sources, the Lyon County Board of Supervisors was not particularly receptive to the idea of building a reinforced concrete bridge, and Fritz von Emperger was obliged to make the journey to Rock Rapids himself to convince town leaders. The board finally agreed on the condition that the concrete structure would cost no more than a bridge made of wood.[10] Years later von Emperger reflected about the difficulties he encountered with his early projects in the United States, "..at this time there was no reliable American cement and I had no contractor of ... experience. I had to build those bridges myself and to be ... my own foreman."[11]

Hewitt chose a spot for the bridge just outside of Rock Rapids on a county road not far from the railroad tracks. While its location was convenient, this selection of the site was especially appropriate for such a venture because months earlier a prairie fire had destroyed the wooden bridge spanning the crossing.[12] The bridge traversed a small tributary of the Rock River known locally as Dry Run. Dry Run is a seasonal stream and in 1894, a year with very little rainfall, it is likely that no water was running through this gully.

Von Emperger delivered his plans for the bridge in June and construction began immediately. Cement had been ordered from Germany at cost of $3.00 per barrel, $3.25 including transportation. Melan's system called for the insertion of steel

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[9]Buncombe to 'Twenty-Two, 76.

[10]George Raveling, a local historian, recounted this in a 1930s article about the bridge for the Sioux City Journal.

[11]Draffin, History of Concrete, 35.

[12]Proceedings of the Lyon County Board of Supervisors, Book 3, 153.

I-beams in the concrete structure, and early technical reports describe the Rock Rapid bridge as being constructed with 4 or 5" I-beams.[13] However, no receipts for any metal purchase have been found and the local legend holds that old railway stock was used in an effort to save money. This, of course, would be consistent with rural construction practices. In either case, the reinforcing elements were bent to the desired arch shape and spaced 3' apart. The arch has a span of 30', a rise of 3', and width of 16'. The depth of the arch's crown measures 6". The concrete mixture was one part of cement to two parts sand and four parts broken jasper. Since a plain concrete finish was not found to be particularly aesthetically pleasing, Olsen faced the spandrel wall with Sioux Falls jasper, a stone quarried in South Dakota which had been used previously in the some of Rock Rapid's more important buildings. The hand rail was made of 4" gas pipe. The total cost of the bridge was $830.[14] Von Emperger, as engineer of the bridge and owner of the US patent for the Melan system, received a sum of $25.60.[15]

Construction of the bridge went swiftly, and it was opened to traffic that year. For 70 years the Melan bridge carried automobiles and farm machinery with minimal maintenance. The bridge was not, however, free from incident.[16] Railing posts have been replaced at least twice: the first was damaged in a car accident, while the second post was taken out during an attempt to move a house across the bridge.

In 1964, the bridge was almost destroyed when state highway officials deemed its width of 16' too narrow. Kenneth Wallace, the county engineer, however, recognized its significance and spearheaded an effort to save it. The county board of supervisors agreed to contribute the cost of demolition, about $2,500, to moving the bridge to a new site in Rock Rapids if the community could raise in one month's time the remaining $4,913 necessary for its transport. With contributions from the Kiwanis

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[13]"First Reinforced Concrete Bridge," 1915 Iowa State Highway Commission Annual Report, 55; and Meuser, The Cornell Engineer, May 1925.

Iowa State Highway Commission.

[15]Meuser, The Cornell Engineer, p.163.

[16]Soon after the bridge was completed a local farmer lost his life on the bridge when a cow he was leading became uncontrollable, entangling him in the lead ropes and tossing him over the rail. Raveling, Sioux City Journal.

Club, E.O. Olsen (son of John Olsen), and many citizens of Lyon County, the goal was reached, and the reinforced concrete arch was moved about 4 miles to a roadside park on the east side of town.[17] An unremarkable concrete structure, with a 28' foot width and $17,000 price-tag, replaced the Melan arch.

Moving a concrete bridge is not a venture that has been tried often. The transport of the Melan Arch was a complicated procedure requiring three phases.[18] The first phase was removal of the bridge from its site at Dry Run and placing it on rollers. To prevent the arch from spreading, the bridge was first heavily braced with wood. The abutments were tied with five steel rods which absorbed the arch's lateral thrust. The next phase involved transporting the bridge to its new site on state highway property.[19] The bridge, including bracing, weighed about 90 tons which was a load large enough to burst all the tires of the first flatbed upon which it was placed.[20] Eventually, the contractors, Graves Construction Company, succeeded in carrying the bridge to its present site on a 40 wheel flatbed. The bridge was situated on new concrete pedestals in the final phase. Then the contractor built earth approaches to the floor bed so that it could be crossed by pedestrians.

On September 3, 1964 the Melan bridge was dedicated as a memorial to the county pioneers who built the community. With its placement next to the highway at the eastern edge of town, the concrete arch was to serve as reminder to those who entered Rock Rapids of the historic achievements and visionary foresight of the town's early settlers. In the 1960s its setting with

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[17]From several 1964 articles of the Lyon County Reporter, including: "Moving of bridge is underway now," April 30; "Saving old bridge a worthy project" April 6; 'Save the Bridge' project spurts as time narrows," March 23; "Schedule start of work Wednesday morning on moving of old bridge" April 23.

[18]"Bids opened at Friday meeting of supervisors," Lyon County Reporter, March 2, 1964. In addition to the local newspaper, several publications relating to construction and concrete covered the move.

[19]Another park on the west side of town had been also proposed as a resting place for the old bridge, but moving the bridge across the river and across railroad tracks would have increased the costs of operation significantly.

[20]From a personal conversation with Roscoe Pettengill, a Rock Rapids resident who was active in the effort to save the bridge.

neighboring properties was quite natural. Today the Melan bridge sits in the shade of Rock Rapids' massive new water tower, surrounded by playground equipment and barbecues. The site has been renamed Emma Sater Park.

A plaque in front of the memorial which reads, "The First Reinforced Concrete Bridge" is misleading, as were many of the articles written during the campaign to save the bridge. The Rock Rapids arch was not the first reinforced concrete bridge built in the United States, but the first reinforced concrete bridge built using the Melan System. Von Emperger knew this himself and wrote in his 1894 article, "the writer knows of but three concrete-iron bridges in this country."[21] He failed to list what bridges these were, or who had designed them, but this was probably because they had not been a great influence on his work.

Von Emperger clearly stated who he thought had made the most significant contributions in the development of reinforced concrete, and these same men today are recognized as being the subject's pioneers.[22] The idea of using iron and concrete together came from France. As far back as the eighteenth century French architects had proposed using iron beams to strengthen their masonry against bending. Architects and builders in the United States and England adopted the idea during the first half of the nineteenth century, and it was an Englishman, William Wilkinson, who first extended this technique to concrete.[23] He received a patent for imbedding a grid of wire rod into a concrete slab in 1854.[24] Von Emperger fails to mention Wilkinson in his report, and credits the Frenchman Josef Monier with the invention of the concrete-iron combination.[25] In 1867 Monier obtained a patent for using wire mesh to strengthen the concrete of his gardening pots and tubs. On the subject of Monier's discovery of reinforced concrete, von Emperger writes, "it is idle to state that he was not the discoverer of the process; but he perceived the value of his method, developed it with the help of trained engineers and capitalists, and, what is always the

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[21]Von Emperger, 439.

[22]Ibid, 438-445.

[23]Elliot, Technics and Architecture. 176-177.

[24]Condit, American Building. 168; and Elliot, 165.

[25]Monier is considered by many to be the inventor of reinforced concrete.

most important, he made a success of it."[26] Francois Coignet introduced the idea of using iron bars as reinforcement at the Paris Exposition also in 1867. Von Emperger mentions that the Coignet system had been employed in constructing many successful bridges in Europe with spans ranging from 75 to 140 feet.[27] However, this was not the system he had come to America to promote.

In his speech, von Emperger mentioned three Americans who had made significant contributions to the development of reinforced concrete, Phineas Ball of Massachusetts, N. Poulson of New York, and Ernest Ransome of California.[28] It was Ransome who built the very first reinforced concrete bridge in the United States in 1889, five years before von Emperger built his in Rock Rapids. Ransome's bridge had a clear span of only 20', but its width was 64', making it resemble more a barrel vault than an arch. This bridge stills stands in its original location in Golden Gate Park in San Francisco. Unlike the Melan Bridge which was constructed with stiff steel members, the Ransome bridge used a grid of iron rods as reinforcement. Von Emperger probably knew of this bridge, although he never refers to it directly in his report.

While Ransome's placement of reinforcement resembles modern practice much more than the Melan system it predated, the latter system proved to be the popular model with early concrete bridge builders.[29] Its attractiveness was rooted in its conservative approach. A Melan arch, with its skeleton of bulky bent steel members, looked more trustworthy than a concrete arch made with a

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[26]von Emperger, 439.

[27]Ibid.440.

Another Frenchman Francois Hennibique later built an empire exploiting the basic premise behind this invention. His modifications to this system were widely published and patented in Europe, and his ideas were just beginning to take hold in America during the 1890s. His method set precedence for many of the later developments in reinforced concrete technology.

[28]von Emperger, 439.

[29]This is not to say the Ransome bridge was not copied. In fact the second bridge, built in Chicago the following year, used the same system.

flimsy iron grid. It was also easier to construct. Von Emperger emphasized these points,

> "The (I) beams are, of course, the stiffest shape to be had. They are a kind of centering (in themselves). It is not difficult to show that these bent beams would safely carry alone the load intended, and it is hard to understand why this simple construction has not been thought of before. Simplicity in all details is a property which will certainly be appreciated in this country. No strain sheets, no worked-out plans, are needed. All that we must know are four figures - span, rise, section of beam, and distance between."[30]

Von Emperger was a good salesman. "It is a very remarkable saving of iron, and at the same time, an advance in strength," he boasted.[31] Of course, this was not entirely true. The concrete arch had indeed been strengthened, but by an inefficient use of steel. In the 1890s, engineers and builders had not yet acquired the confidence to know that they could get by with much less steel, although they did understand the basic principles behind the workings of reinforced concrete. They knew that concrete was ten times stronger in compression than in tension, and that arch bridges would fail in tension if there were loaded non-uniformly. Designers of traditional plain arches had avoided tensile failures by building their arches with sturdy proportions. This way the dead load would be so massive that the effects of any erratic live load would be inconsequential. Those who had studied some engineering knew about the middle third rule which stated that the line of the force must follow a path that approximated the centerline of the arch.[32] If the line of force was swayed out of the middle third portion to the interior (intrados) or exterior edge (extrados) of the arch, areas of tensile stress would be created causing the arch to crack and potentially, to collapse.[33] When steel, a material strong in tension, is entered into the equation, the line of force no longer needs to remain in the center third. Von Emperger thus promoted his product, "This enables us to build flat as well as

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[30]Von Emperger, 444.

[31]Ibid.

[32]The line of force, or resulting force vector, approximates the line of thrust in an arch.

[33]This concept is presented and proven in fundamental static courses.

thin arches, saving 67% and more, in comparison with stone."[34] It was difficult to prove this assertion in his first project, a span of only thirty feet. Fortunately, he would have many other opportunities.

During his short stay in America, von Emperger established a practice under the name of Melan Arch Construction Company in New York City.[35] After his first humble attempt at Rock Rapids, von Emperger designed several other Melan Bridges which had much more impressive dimensions. He began his next project less than a year later in Cincinnati, Ohio. This bridge, built in Eden Park, had a span had a span of 70 ft. In his next project, von Emperger increased the span to 100 feet, having a 10 foot rise, in his design for a footbridge in Stockbridge, Massachusetts.[36] Von Emperger left the United States in 1895 or 1896, leaving his firm under the leadership of his design engineer, William Meuser. Meuser ran the company alone for several years until forming a partnership in 1900 with Edwin Thacher.[37] A few years earlier, while serving as the western agent for the Melan Arch Company, Thacher had designed one of the most remarkable early Melan bridges for the city of Topeka in 1896. Spanning the Kansas River, the bridge was comprised of five arches, with the longest measuring 125'.[38] Although the Melan construction system remained their specialty, Meuser and Thacher changed the firm's name to Concrete Steel Engineering Company.[39] The Melan method spread quickly, and in the first decade of the twentieth century, cities across the country were requesting multiple arch designs for their major river spans.

Despite the large quantities of steel required, the Melan system remained popular in the United States through the 1930s, reaching

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[34]Von Emperger, 44.

[35]From a deposition given by William Meuser in the Luten vs. Marsh Engineering Company case, a bridge patent litigation suit filed in Iowa in 1912. The defense was represented by the State Attorney General.

[36]Ute Georgeacopol, "Zwei Brucken im k.k. Hofstallgebaude." *Steinschlag*. No. 101. Vienna. Oct-Dec, 1994.

[37]Meuser, Deposition, 117.

[38]David Plowden, Bridges: The Spans of North America. Viking Press. New York. 1974. 299.

[39]Meuser. Deposition, 117.

considerable lengths. The Larimer Bridge in Pittsburgh, constructed in 1912, had an arch spanning 280'. In 1923, the Cappelen Memorial Bridge was built with a center span of 370'.[40] Unfortunately for von Emperger, the Melan system never enjoyed the same success in Europe. Although von Emperger's enterprising campaign is responsible for the immediate popularity of the bridge type, the Melan System remained a favorite of American bridge builders for two reasons: its conservative aesthetic appeal, and the ease of its construction. Meuser once explained,

> "Labour in the United States is relatively expensive, from the labourer to the engineer. As a result, simpler designs ...are preferred. The Monier construction method, for example, has not gained foot hold...The Melan method immediately met with increasing interest primarily because the reinforcement was placed in the form of easy to assemble arches. This assured that a good bond between both materials could be expected even under the most unfavorable conditions."[41]

Despite its extensive use, the Melan system did not foretell new directions in reinforced concrete design. With its substantial structural reinforcement, the method instilled confidence in turn-of-century bridge builders and engineers who were still unsure of the possibilities of reinforced concrete. The Melan Arch Bridge marks an important step in the history of the material and in the history of bridge building. Although von Emperger's tiny concrete-iron arch bears little resemblance to the reinforced concrete spans of today, the system introduced in Rock Rapids heralded a new age of American bridge design.

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[40]Hans Wittfoht, Building Bridges: History, Technology, Construction. Beton-Verlag, Dusseldorf. 1984. 139-140.

[41]From a article for a German journal ("Die Erfolge der Eiseneinlage in den Eisenbetonbauten Nordamerikas." Deutscher Beton-Verlag. Vortrage 1904. 115), as reprinted in Wittfoht.213.

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ADDENDUM TO
MELAN ARCH BRIDGE
(Bridge, Reinforced Concrete Arch)
Iowa Historic Bridges Recording Project
Emma Slater Park (Moved from Dry Run Creek)
Rock Rapids vicinity
Lyon County
Iowa

HAER No. IA-15

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HISTORIC AMERICAN ENGINEERING RECORD
National Park Service
1849 C Street, NW
Washington, DC 20240

HISTORIC AMERICAN ENGINEERING RECORD HAER
IOWA
MELAN ARCH BRIDGE 60-ROCRA.V,
(Bridge, Reinforced Concrete Arch) 1-

This appendix is an addendum to a 16-page report previously transmitted to the Library of Congress.

APPENDIX: ADDITIONAL REFERENCES

Interested readers may consult the Historical Overview of Iowa Bridges, HAER No. IA-88: "This historical overview of bridges in Iowa was prepared as part of Iowa Historic Bridges Recording Project - I and II, conducted during the summers of 1995 and 1996 by the Historic American Engineering Record (HAER). The purpose of the overview was to provide a unified historical context for the bridges involved in the recording projects."

This bridge was also covered by the Structural Study of Reinforced Concrete Arch Bridges, HAER No. IA-89: "Three reinforced concrete arch bridges, built in the late nineteenth and early twentieth century by three prominent engineers promoting this type of bridge design, were selected for engineering analysis and evaluation based on modern structural theory and structural theory as it was known at the time the bridges were constructed."